

REMARKS

Claims 26-29, 33-35, and 37-40 are amended. Claim 36 is cancelled herein without prejudice to its underlying subject matter. Claims 1-25 were previously cancelled without prejudice. Claims 26-35 and 37-40 are pending in the application.

Claims 26 and 27 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,312,775 ("Fujii et al.") in view of U.S. Patent No. 6,268,284 to Cerio, Jr. ("Cerio"). This rejection is respectfully traversed.

Claim 26, as amended, defines a semiconductor device and recites, in part, "a first titanium aluminide layer lining at least a bottom of the via hole" and "a second titanium tungsten layer at least on sides of said via hole" and "a conductive material on the first titanium aluminide layer." Neither Fujii et al. nor Cerio teaches or suggests these features of the claimed device. Neither of these references teaches or suggests use of a titanium tungsten layer, for example. For at least this reason, these references, whether taken individually or in combination, would not have rendered the claimed invention obvious.

Claim 27, as amended, defines a semiconductor device and recites, in part, "a titanium aluminide layer lining a bottom and sides of the via hole" and "a titanium tungsten layer over the titanium aluminide layer" and "a conductive plug material on the titanium tungsten layer." Fujii et al. and Cerio, individually or in combination, do not teach or suggest, for example, use of a titanium tungsten layer combined with the other recited features of the claimed device. Therefore, as with claim 26, Fujii et al. and Cerio would not have rendered the claimed subject matter obvious.

Because the references Fujii et al. and Cerio, whether or not combined, would not have taught or suggested each and every limitation of claims 26 and 27, these

claims are patentable over the references. Applicant respectfully requests that the 35 U.S.C. § 103(a) rejection of claims 26 and 27 be withdrawn.

Claims 28-35 and 37-40 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Fujii et al. in view of Cerio and further in view of U.S. Patent No. 5,358,901 ("Fiordalice et al."). This rejection is respectfully traversed.

Applicant respectfully submits that Cerio and Fiordalice et al. teach away from their combination. Fiordalice et al. teaches away from using Cerio's sputtering techniques, stating, "titanium aluminide is formed by reacting gaseous titanium tetrachloride with aluminum in the interconnect without sputtering or evaporating titanium." (Col. 4, lines 27-30). Fiordalice et al. explains that sputtering leaves unwanted titanium on the sidewalls of the via: "[i]f the titanium-sputter method was used to form titanium aluminide within the via opening. . . unreacted titanium probably would lie on the ILD layer 51 and on the titanium aluminide that is formed at the bottom of the via opening." (Col. 5, lines 7-12). Cerio, likewise, teaches away from the method of Fiordalice et al., stating "when Ti and Al are reacted to form $TiAl_3$, undesirable roughening of the interface between $TiAl_3$ and the overlying Al layer is observed." (Col. 5, lines 23-25). Cerio explains that using this method, as Fiordalice et al. teaches, produces a layer that is not smooth, and therefore undesirable for Cerio's method.

Thus, one of ordinary skill in the art would not be motivated to combine Fiordalice et al. with Cerio because each reference teaches away from using the method of the other. The combination of references is therefore improper according to M.P.E.P. § 2145. The rejection cannot stand without the inclusion of subject matter from each of the references cited thereunder, therefore withdrawal of the 35 U.S.C. § 103(a) rejection of claims 28-35 and 37-40 is respectfully requested.

Additionally, Applicant respectfully submits that the combination of Fujii et al., Cerio, and Fiordalice et al., even if not improper, which it is, would still not teach or suggest the invention defined by each of claims 28-35 and 37-40.

Claim 28, as amended, defines a semiconductor memory device and recites, in part, “a titanium aluminide layer lining at least a bottom of the via hole” and “a titanium tungsten compound containing layer on the titanium aluminide layer and in contact with said titanium aluminide layer at an interface that is substantially free of tensile stress” and “a conductive plug material on the titanium tungsten compound layer.” As discussed above in relation to the patentability of claims 26 and 27, neither Fujii et al. nor Cerio teaches or suggests, for example, use of a titanium tungsten compound layer over a titanium aluminide layer. Fiordalice et al. likewise does not teach or suggest such a feature of a memory device. Therefore, these references, even if combinable, would not have rendered the claimed invention obvious. Claims 29-32 depend from claim 28 and are patentable over the references for the same reasons.

Claim 33, as amended, defines a memory module and recites, in part, “a titanium aluminide layer lining at least a bottom of the via hole” and “a titanium tungsten compound containing layer over the titanium aluminide layer” and “a conductive plug material formed over the titanium tungsten compound layer, said conductive plug comprising a material selected from the group consisting of molybdenum, titanium, and tantalum.” As discussed above, not one of Fujii et al., Cerio, and Fiordalice et al. teaches or suggests the recited titanium tungsten compound layer. Additionally, none of these references teaches or suggests the claimed device having a conductive plug comprising molybdenum, titanium, or tantalum. For both of these reasons, the subject matter of claim 33 would not have been obvious over the references, even if they could be combined.

Claim 34, as amended, defines a memory module and recites, in part, “a first titanium aluminide layer lining a bottom and sides of the via hole” and “a second titanium tungsten layer over said first titanium aluminide layer.” As discussed above, none of Fujii et al., Cerio, and Fiordalice et al. teaches or suggests, for example, a titanium aluminide layer and a titanium tungsten layer thereover. For at least this reason the subject matter of claim 34 would not have been obvious over these references, even if they were combinable.

Claim 35, as amended, defines a memory module and recites, in part, “a titanium aluminide layer lining a bottom of the via hole” and “a titanium tungsten layer substantially free of through cracks on the titanium aluminide layer” and “a conductive plug material on the titanium nitride layer, said conductive plug material being selected from the group consisting of molybdenum, titanium, and tantalum.” As discussed above, none of the cited references teaches or suggests either the combined titanium aluminide layer and titanium tungsten layer, or a conductive plug material selected from molybdenum, titanium, and tantalum. For either of these reasons, the references, even if combinable, would not have rendered the claimed invention obvious.

Claim 37, as amended, defines a computer system, comprising a processor and a random access memory (RAM) fabricated on a semiconductor chip communicating with the processor and recites, in part, “a titanium aluminide layer lining a bottom and sides of the via hole” and “a titanium tungsten containing layer over the titanium aluminide layer.” As discussed above, the cited references, combined or not, do not teach or suggest a titanium tungsten containing layer over a titanium aluminide layer. Thus, the subject matter of claim 37 would not have been obvious over the references.

Claim 38, as amended, defines a computer system, comprising a processor and a random access memory (RAM) fabricated on a semiconductor chip communicating with the processor and recites, in part, “a first titanium aluminide layer lining at least a bottom of the via hole” and “a second titanium tungsten layer lining at least the sides of the via hole.” As discussed above, there is no teaching or suggestion of these recited features in any of the cited references. Therefore, even if Fujii et al., Cerio, and Fiordalice et al. could be combined, they would not have rendered the subject matter of claim 38 obvious.

Claim 39, as amended, defines a computer system, comprising a processor and a random access memory (RAM) fabricated on a semiconductor chip communicating with the processor and recites, in part, “a titanium aluminide layer lining a bottom of the via hole” and “a titanium tungsten layer substantially free of through cracks on the titanium aluminide layer.” As discussed above, none of the cited references teaches or suggests, for example, the recited titanium tungsten layer. For this reason, the subject matter of claim 39 would not have been obvious over the references even if they were combinable.

Claim 40, as amended, defines a computer system, comprising a processor and a random access memory (RAM) fabricated on a semiconductor chip communicating with the processor and recites, in part, “a titanium aluminide layer lining a bottom and sides of the via hole” and “a titanium tungsten layer over said titanium aluminide layer” and “a conductive plug material on the titanium tungsten layer, said conductive plug material comprising a metal selected from the group consisting of molybdenum, titanium, and tantalum.” As discussed above, such a device is not taught or suggested by Fujii et al., Cerio, and Fiordalice et al., individually or in combination (even if they were combinable, which they are not). Neither the recited titanium tungsten layer nor the conductive plug materials is taught or suggested

by the references. For these reasons, the subject matter of claim 40 would not have been obvious over the references.

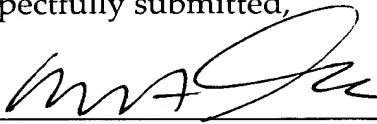
For at least the reasons set forth above, claims 28-35 and 37-40 would not have been obvious over Fujii et al., Cerio, and Fiordalice et al., even if they were combinable, which they are not. Withdrawal of the 35 U.S.C. § 103(a) rejection of claims 28-35 and 37-40 is respectfully requested.

Claim 36 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 4,656,605 ("Clayton") in view U.S. Patent No. 5,313,101 ("Harada et al."). Claim 36 has been cancelled.

In view of the above, each of the presently pending claims (26-35 and 37-40) in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to pass this application to issue.

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Respectfully submitted,

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